

FL-110 LINEAR AMPLIFIER



GENERAL

The FL-110 is an all solid state linear amplifier designed to match the FT-301S and FT-7 transceivers covering ham bands 160 through 10 meters.

The FL-110 uses a pair of SRF-1427 transistors in a push-pull, broad-band linear amplifier circuit configuration with negative feedback reducing the distortion and spurious radiation.

The Automatic Level Control Circuit controls the exciter gain to allow the highest average power without distortion caused by peak clipping, and, protects the PA transistor from destruction due to overdrive.

An internal change-over relay is operated automatically by either a transmitted signal or PTT switch in the exciter.

CAUTION

DO NOT EXCEED RATED DRIVE
POWER OR DESTRUCTION OF
THE PA TRANSISTOR MAY RESULT.

SPECIFICATIONS

Circuit	-	Transistorized push-pull, wide-band linear amplifier.
Frequency Coverage	-	Ham bands 160 through 10 meters.
Wave Form	-	SSB, AM, CW and FSK
Max. Drive Power	-	15 watts CW, SSB 4 watts AM, FSK
Input Impedance	-	50 ohms unbalanced
Output Impedance	-	50 ohms unbalanced
Max. Input Power	-	200 watts DC SSB, CW 75 watts DC FSK 50 watts DC AM
Distortion	-	Better than 31 db
Spurious Radiation	-	Less than -40 db
Power Requirement	-	13.5V DC +10% negative ground Receive 0.05 amps Transmit 17 amps at 100 watts Output 14 MHz
Size	-	120(W) x 100(H) x 200(D) m/m
Weight	-	2.5 kg

SEMICONDUCTOR COMPLEMENT

IC	PC271C	(1)	DIODE	1S-1007	(12)
TR	2SC372Y	(1)		10D1	(3)
	2SC735Y	(1)		10D10	(2)
	2SD235	(1)		SG103D	(1)
	SRF1427	(2)		SR103D	(2)
				CW01B	(1)

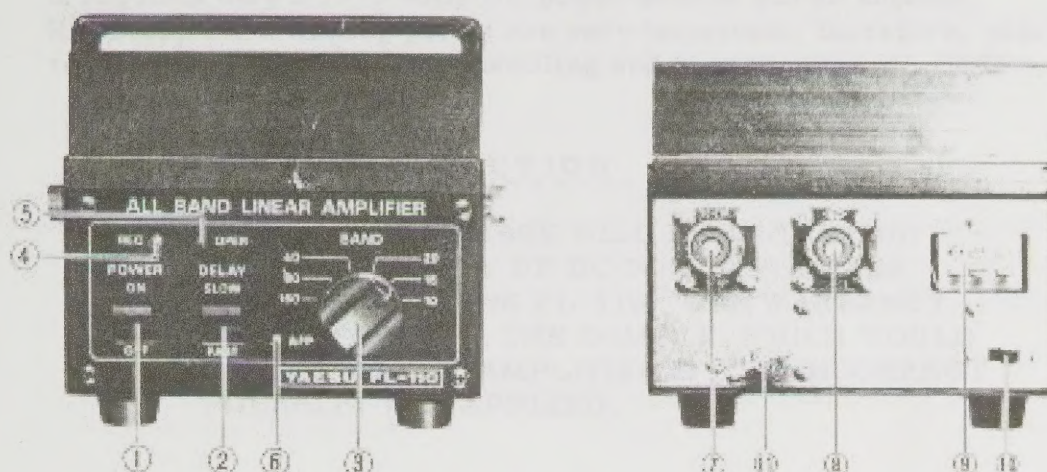
"CAUTION"

EXCEEDING CURRENT LEVEL AS LISTED IN OPERATING MANUAL
MAY CAUSE SPURIOUS IN VIOLATION OF FCC RULE 97.73.

Digitized by the Internet Archive
in 2023 with funding from
Amateur Radio Digital Communications, Grant 151

<https://archive.org/details/fl110linearampli00unse>

CONTROLS, INDICATORS & CONNECTORS



Front Panel

- | | | |
|-----------|---|---|
| (1) POWER | - | Switch to turn power "ON". |
| (2) DELAY | - | Switch selects relay hold time for carrier operated change-over. Relay time is 0.1 - 0.2 seconds for FAST and 0.3 - 1.0 seconds for SLOW positions. |
| (3) BAND | - | Switch selects the Amateur band between 160 and 10 meters. |

INDICATORS

- | | | |
|-----------|---|---|
| (4) REC: | - | Green lamp indicates receive mode. |
| (5) OPER: | - | Red lamp indicates transmit mode. |
| (6) AFP: | - | Red lamp indicates that the AFP circuit is in operation and that the linear amp is shut down. |

Rear Panel

- | | | |
|-----------|---|---|
| (7) INPUT | - | Input connector for the drive from exciter. |
| (8) ANT | - | Antenna connector. |
| (9) POWER | - | DC-13.5V, 20A power input. External PTT control terminal is included. |
| (10) PTT | - | Switch to select relay polarity. |
| (11) GND | - | Ground connection. |

INSTALLATION AND OPERATION

The FL-110 Linear Amplifier is installed and operated very simply. It requires only a 13.5 volts DC power source and an antenna. However, the following points are very important, therefore, please read them carefully before installing and operating the FL-110.

CAUTION

PERMANENT DAMAGE WILL RESULT IF THE WRONG POLARITY OF DC POWER VOLTAGE IS APPLIED TO THE FL-110. OUR WARRANTY DOES NOT COVER THE DAMAGE WHICH WOULD RESULT TO THE AMPLIFIER IF THE INCORRECT POLARITY WAS APPLIED.

The FL-110 will operate satisfactorily from any 12 - 14 volts DC power source having a 20A current capacity. When making connections to the power source, be certain the the ORANGE lead is connected to the positive (+) and the BLACK lead to the negative (-).

The power cable should be as short as possible to minimize voltage drop and to provide a low impedance path from the FL-110 to the power supply.

Prior to operating the FL-110 in a mobile installation, the automobile's voltage regulator setting should be checked. In many vehicles, the voltage regulator is very poor and, in some cases, the regulator may be adjusted for an excessively high charging voltage. It is necessary to carefully set the regulator so that the highest charging voltage does not exceed 14 volts.

No special installing precautions need be observed if adequate ventilation space is available. However, it is recommended that excessively warm locations, such as car heater ducts, should be avoided. The FL-110 should be installed in such a way so that the heat sink is on top.

It is also very important that the antenna used with the FL-110 presents a fairly close 50 ohms non-reactive load. If the SWR is as high as 2:1, the output power decreases and the AFP circuit will work with SWR 3:1 to protect the power transistor.

The FL-110 can be keyed either manually or automatically.

For manual operation, use the accessory relay output of the transceiver in use as illustrated in Fig. 1. With this interconnection, the FL-110 is keyed by push-to-talk operation of the transceiver.

Carefully examine the relay function of the transceiver.

The switch marked PTT on the rear panel should be set to (-) for the transceiver which has the accessory relay contact close to ground in transmit (FT-101 series). It should be set to (+) position for the transceiver which has the relay contact close to a positive voltage in transmit (FT-301 series).

Use a coax cable for the connection between the transceiver and the FL-110 linear amplifier.

CAUTION

THE DRIVING POWER SHOULD NOT EXCEED 15 WATTS UNDER ANY CIRCUMSTANCES.

DO NOT KEY THE FL-110 WITHOUT THE PROPER ANTENNA BEING CONNECTED.

THE COLLECTOR OF THE PA TRANSISTOR IS CONNECTED TO THE POWER SOURCE AND DRAWS 5 MILLIAMPS WHEN THE POWER SWITCH IS AT "OFF" POSITION. THEREFORE, IT IS RECOMMENDED TO DISCONNECT POWER CABLE FROM THE BATTERY WHEN THE FL-110 IS NOT BEING USED FOR SEVERAL MONTHS.

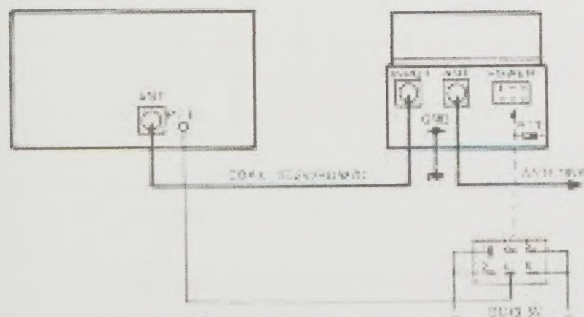


Figure 1

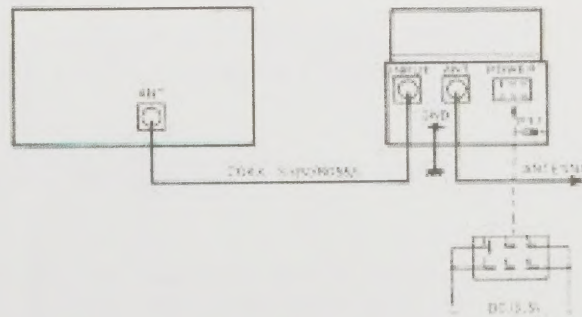


Figure 2

When the power switch is set to "OFF" position, the FL-110 does not operate and the antenna is directly connected to the transceiver. When the power switch is "ON", a green lamp lights up and the FL-110 is keyed together with the transceiver. On transmit, a red lamp lights up.

The FL-110 can operate automatically when the transceiver is operated by VOX (voice controlled) mode. The transmitter carrier from the transceiver controls the change-over relay in the FL-110. The relay hold time is set to either FAST or SLOW to select delay time of the change-over relay. When the FL-110 is operated with the lower driving power of less than 1 watt, the carrier operated change-over circuit does not function.

CAUTION

IF THE AFP (AUTOMATIC FINAL PROTECTION) CIRCUIT STARTS TO WORK, A RED WARNING LAMP LIGHTS UP SHOWING THAT THE LINEAR AMPLIFIER IS NOT FUNCTIONING.

IF THIS HAPPENS, TURN THE POWER SWITCH "OFF" AND CHECK FOR THE CAUSE OF TROUBLE WHICH WILL BE EITHER A DEFECTIVE ANTENNA SYSTEM OR OVERDRIVE FROM THE EXCITER.

AFTER ELIMINATING THE PROBLEM, THE AFP CIRCUIT CAN BE RESET BY TURNING THE POWER SWITCH "ON".

CIRCUIT DESCRIPTION

The PL-110 consists of four major parts -- COUPLING UNIT, CONTROL UNIT, BOOSTER UNIT and LPF unit. On receive mode, a received signal is fed through J1, RL1 and J2 to the transceiver antenna terminal.

On transmit, the output signal from the transceiver antenna passes through the CM coupler T101 in the coupler unit PB-1680 where the RF voltage is detected and applied to the control unit PB-1681 in order to activate the relay RL1.

A forwarding wave is detected by the voltage doubler rectifier D101 and D103, 1S-1007 and a reflected wave is detected by D102 and D104, 1S-1007. The rectified DC voltages are applied to a comparator Q204, μ PC-271C which controls relay driver, Q201, 2SC372Y and Q202, 2SC735Y. With high reflected wave, such as VSWR 1:3, the output of Q204 is low and the relay driver circuit does not function.

A part of the DC voltage obtained from the forwarding wave is applied to the AFP circuit in order to operate RL201 to disconnect the activating voltage for RL1 thus protecting the PA transistors from damage due to overdrive. The relay hold time is set to either FAST or SLOW by adding C201 for a longer discharge time.

When RL1 is activated, the bias voltage is applied to the PA transistors and the amplifier starts to operate.

The driving power is fed through the equalizer circuit consisting of R1210, R1211, C1201, C1202, R1201, R1202 and L1201 to the input transformer T1201 to be amplified by Q1201 and Q1202, SRF-1427 which works as a wide-band linear amplifier in a push-pull configuration.

The Negative Feedback circuit consisting of R1206, L1204, R1204 and L1203 improves the stability and the linearity of the PA stage.

The 13.5 Volt DC voltage is regulated to 0.65 volts by a regulator Q1203, 2SD235 to be used as bias for Q1201 and Q1202. Q1203 is controlled by the voltage generated by D1201 and D1202, 10D10 which varies in accordance with the temperature of the final transistor in order to protect the final transistor.

The amplified output is fed through the Low-Pass Filter Unit, PB-1577 which reduces the harmonic radiation, and then passes through relay RL1 to the antenna.

A portion of the output power is coupled through T301 to the AFP circuit.

The DC voltage obtained by rectifying the forwarding power with D302 and D304, 1S-1007 is fed to Q203, CWC1B which controls RL201 to open RL1 when the output power exceeds preset value set by VR301.

The DC voltage obtained by a reflected power caused by high VSWR (more than 1:3) also controls Q203 to open RL1.

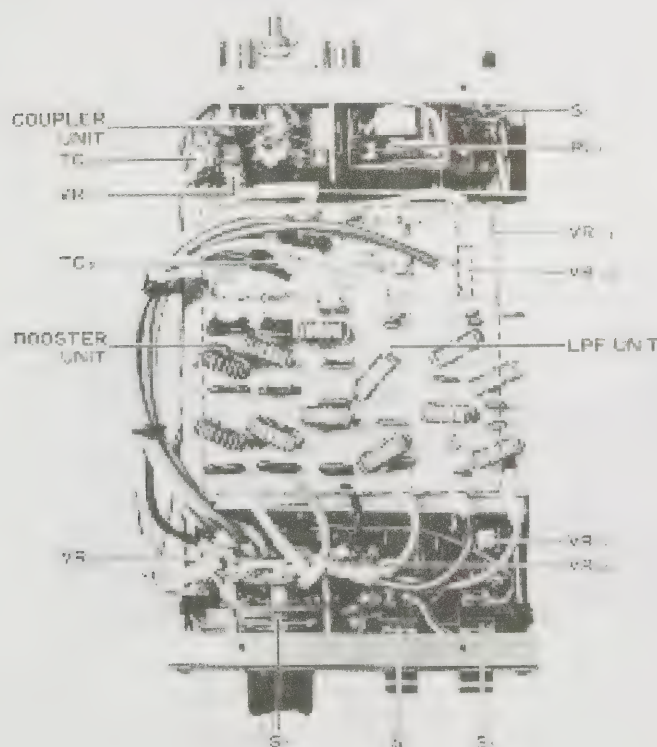
MAINTENANCE AND ALIGNMENT

Your FL-110 Linear Amplifier has been carefully aligned and tested at our factory prior to shipment. The reliability of the solid state devices used in the FL-110 should provide years of trouble-free service if the amplifier is not abused, and, normal routine maintenance is carried out.

The following precautions should be observed to prevent damage to the FL-110.

- (a) Do not exceed 14 Volts DC at the power receptacle. When operating mobile, check the battery voltage under load (full output on CW) with the engine running fast enough so that the car ammeter shows a "charge". Also, do not operate the FL-110 if the supply voltage is below 12 Volts DC.
- (b) Avoid direct exposure to sunshine or water.
- (c) Avoid extremely warm locations and maintain free air circulation around the heat sink.

The FL-110 does not require realignment with normal usage. Service, or replacement of a major component, may require subsequent realignment.



BOTTOM VIEW

REALIGNMENT PROCEDURE

(1) DELAY ADJUSTMENT (VR201)

The relay hold time can be adjusted by VR201. Clockwise rotation of VR201 will produce longer hold time.

(2) BALANCE ADJUSTMENT OF CM COUPLER (TC101, TC301)

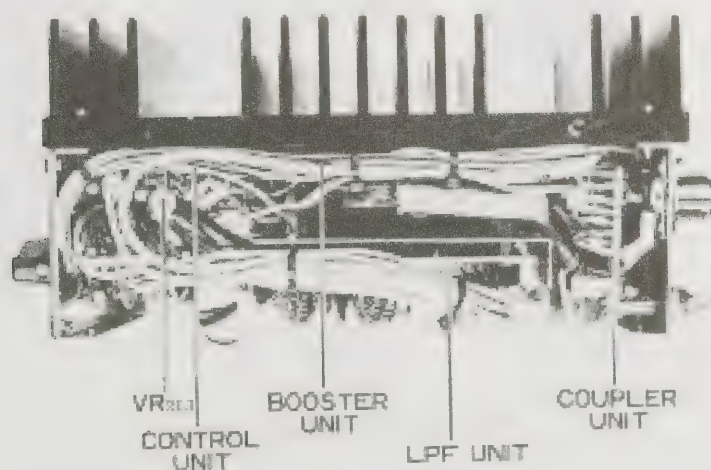
Set the power switch to "OFF". Connect dummy load/wattmeter, YP-150, to antenna connector. Set the output power of the exciter to 10 watts on the 3.5 MHz band. Connect a VTVM between a check point marked "R" in the control unit (+) and ground (-). Adjust TC101 for a minimum VTVM reading (less than 0.05V).

Connect plus (+) lead of VTVM to TP301 in the LPF unit. Set the power switch to "ON". Adjust TC301 for a minimum VTVM reading (less than 0.1 volts).

(3) AFP CIRCUIT ADJUSTMENT (VR202, VR203, VR301)

Prior to this adjustment, complete the adjustment of CM coupler described in Step (2).

Set VR202 to a fully clockwise position and VR203 to a fully counter-clockwise position in the control unit. Set VR301 in the LPF unit to a fully clockwise position. Connect the dummy load/wattmeter to the antenna connector and apply 3.5 MHz 20 watts carrier signal from the exciter. Slowly advance VR202 in a counter-clockwise direction and set VR202 to the point where the AFP relay is activated. Turn the power switch "OFF" and adjust the exciter output to 15 watts. Turn the power switch "ON". The AFP circuit should not work with a 15 watts drive power. If it should work with 15 watts, slowly advance VR203 in a clockwise direction.



RIGHT SIDE VIEW

Repeat this procedure until the AFP circuit works without fail with a 20 watts input and does not work with a 15 watts input.

Then, rotate VR301 in a counter-clockwise direction until the AFP circuit is activated. Slowly rotate the VR301 back approximately 5 degrees in a clockwise direction. Set the exciter to receive. Connect VSWR meter, antenna coupler and dummy load/wattmeter to the antenna connector. Transmit on 3.5 MHz and adjust exciter output and antenna coupler to produce VSWR 1.3 at 70 watts output. Slowly rotate VR203 in a clockwise direction until the AFP circuit is activated.

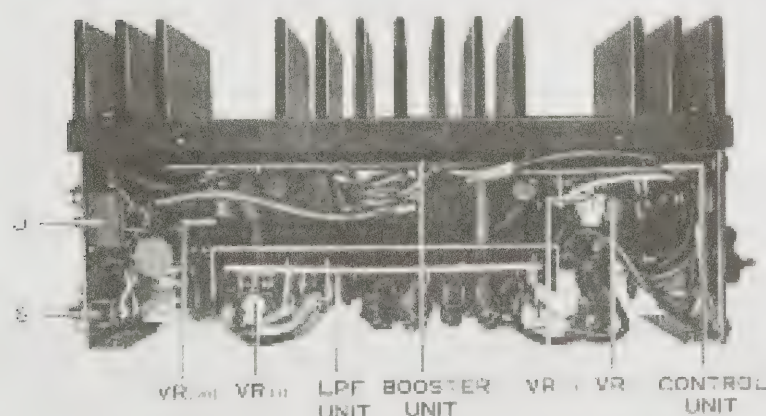
(4) CARRIER CONTROL CIRCUIT ADJUSTMENT (VR101)

After completion of above procedure, disconnect the PTT connection between the exciter and FL-110. Set VR101 to a fully clockwise position. Turn the power switch "ON" and apply 3.5 MHz 10 watts CW signal from the exciter. Carefully rotate VR101 in a counter-clockwise direction until the relay is activated. Recover the PTT connection.

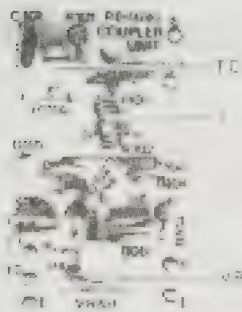
(5) PA BIAS ADJUSTMENT (VR1201)

This adjustment is only required when the PA power transistors are replaced. Otherwise, please do not adjust the VR1201 as an incorrect setting will result in damage to the PA transistors.

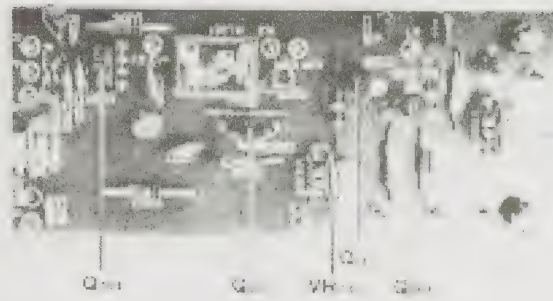
Connect 1A ammeter in the power supply line (cut red wire) to measure PA collector idle current. Disconnect the exciter from the FL-110. Set PTT switch to (-) position. Connect PTT terminal (pin 4) to ground. Turn the power switch "ON". Adjust VR1201 for 100mA idle current. Remove the ammeter from the circuit and recover the wiring cut for the ammeter installation.



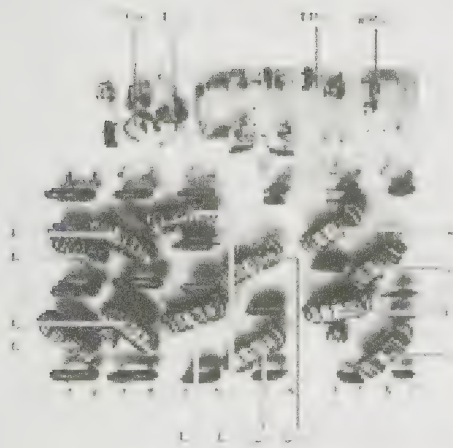
LEFT SIDE VIEW



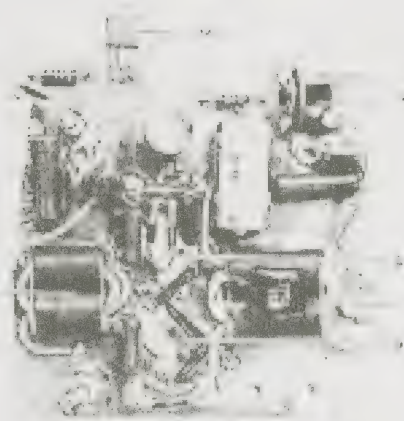
VR



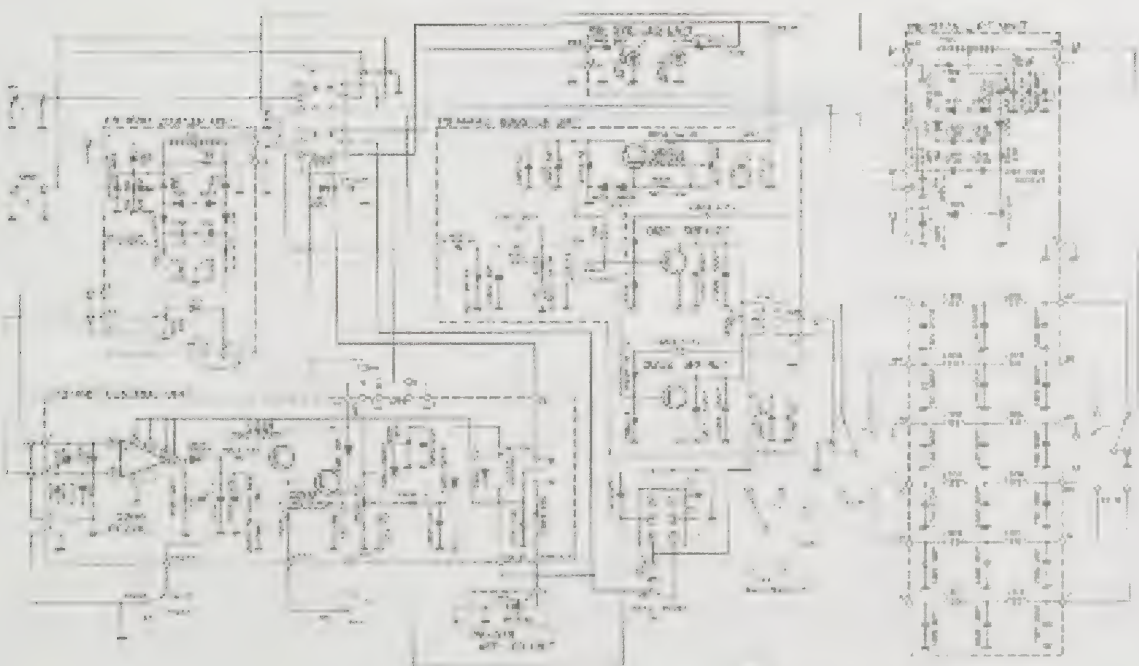
VR



LPR UNIT (PB-157)



BOOSTER UNIT (PB-444B)

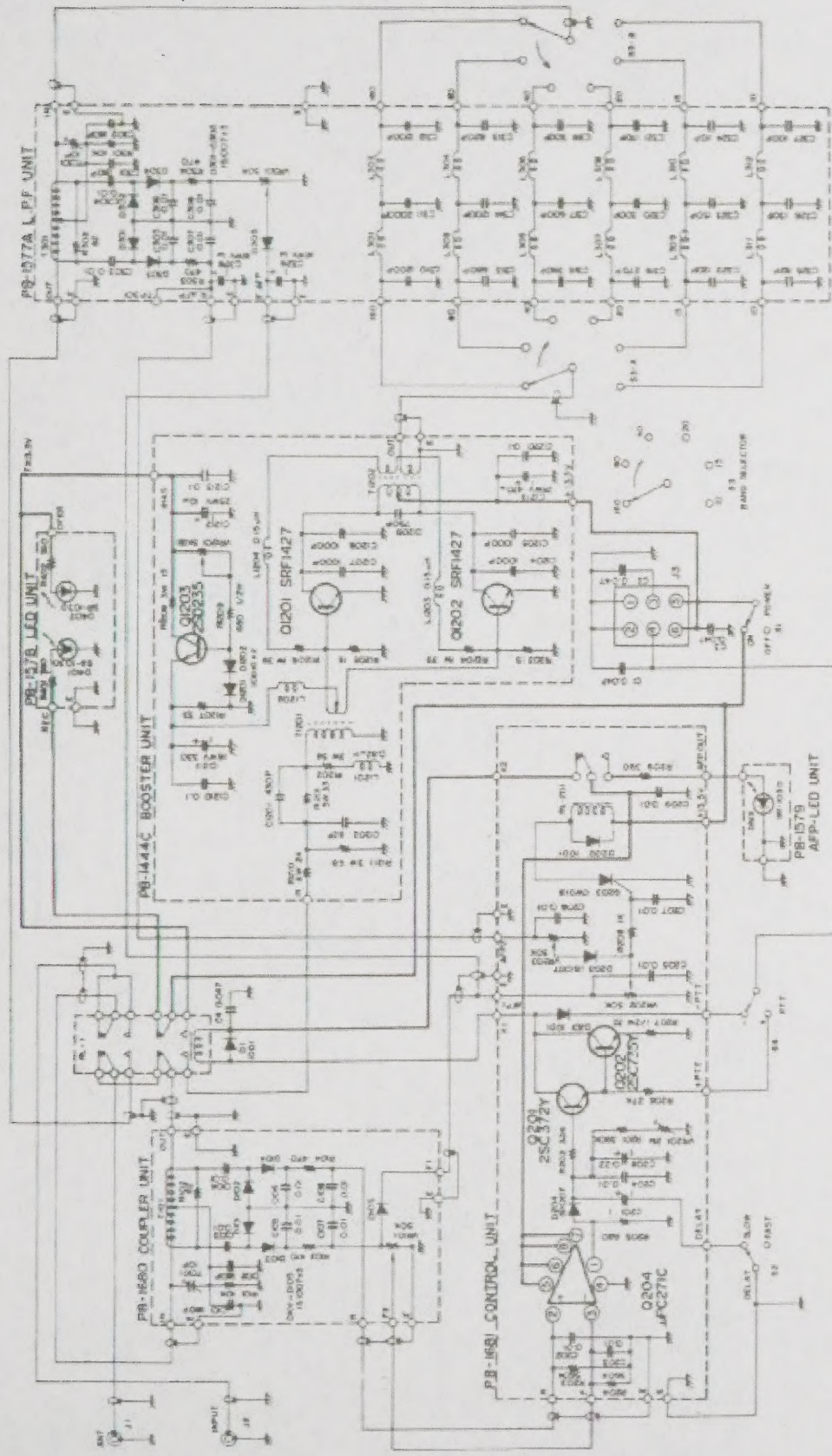


ALL MECHANICAL PARTS
SHOWN IN THIS DRAWING
ARE TO BE USED IN THE
ASSEMBLY OF THE
UNIT

PARTS LIST

MAIN CHASSIS				1219	25WV	470 pF
D	DIODE			T	TRANSFORMER	
1		Si	10D1 (1N4002)	1201	INPUT	# 220027
C	CAPACITOR			1201	OUTPUT	# 220026
	CERAMIC DISC			L	INDUCTOR	
1, 3		50WV	0.047 μ F	1201	RF CHOKE	# 220034
RL	RELAY			1202	RF CHOKE	# 220041
1		AP3241	HC4 DC12V	1203, 1204	RF CHOKE	# 220035
RLS	RELAY SOCKET					
1		AP384455	HC4 SS			
S	SWITCH					
1	POWER		WD-9216	COUPLER UNIT		
2	DELAY		WD-9216	PB	PRINTED CIRCUIT BOARD	
3	BAND	2 2 G	#003505 #003506	1680	(A~Z)	
4	PTT	SS F	22 08	D	DIODE	
J	RECEPTACLE			101 ~ 105	Ge (GB)	1S1007 (1N270)
1	ANT	J50 239		R	RESISTOR	
2	INPUT	J50 239			CARBON FILM	
3	POWER	QMS AB6M		102	$\frac{1}{4}$ W	82 Ω
				103, 104	$\frac{1}{4}$ W	470 Ω
				101	$\frac{1}{4}$ W	10K Ω
				VR	POTENTIOMETER	
				101	EVL VOAA 001354	50K Ω B
BOOSTER UNIT				C	CAPACITOR	
PB	PRINTED CIRCUIT BOARD				DIPPED MICA	
1444D				101, 102	50WV	180PF
Q	TRANSISTOR				CERAMIC DISC	
1201, 1202	SRF1427			103 ~ 108	50WV	0.01 μ F
1203	2SD313E (2SD235)			TC	TRIMMER CAPACITOR	
D	DIODE			101	ECV 1ZW 10 ~ 40	10PF
1201, 1202	Si	10D10		T	TRANSFORMER	
R	RESISTOR			101	CM COUPLER	# 220027
	CARBON COMPOSITION					
1207	$\frac{1}{4}$ W	3.3 Ω				
1203, 1205	$\frac{1}{4}$ W	15 Ω				
1209	$\frac{1}{4}$ W	680 Ω				
	METALIC FILM					
1204, 1209	1W	39 Ω				
1208	3W	15 Ω				
1202	3W	56 Ω				
1211	3W	68 Ω				
1201	5W	33 Ω				
1210	6W	24 Ω				
VR	POTENTIOMETER					
1201	V18K3-2	5K Ω B				
C	CAPACITOR					
	DIPPED MICA					
	500WV	82PF				
1201	500WV	430PF				
1209	500WV	750PF				
1204, 1205, 1207, 1208	500WV	1000PF				
	CERAMIC DISC					
1210, 1213, 1220	50WV	0.1 μ F				
	ELECTROLYTIC					
1211	16WV	330 μ F				
1212	25WV	10 μ F				

203, 204	1/4W	550K Ω	L	INDUCTOR	
			301, 320	160m LOWPASS	# 220148A
	CARBON COMPOSITION		303, 304	80m LOWPASS	# 220147A
207	1/4W	22 Ω	305, 306	40m LOWPASS	# 220214
			307	20m LOWPASS(A)	# 220254
VR	POTENTIOMETER		308	20m LOWPASS(B)	# 220215A
202, 203	EVL VOAA	00B54 50K Ω B	309	15m LOWPASS(A)	# 220216
201	EVL VOAA	00B26 2M Ω B	310	15m LOWPASS(B)	# 220217
			311, 312	10m LOWPASS	# 220218
C	CAPACITOR				
	CERAMIC DISC				
202 ~ 207, 209, 210	50WV	0.01 μ F			
	TANTALUM				
208	16WV	0.22 μ F		LED BOARD	
201	16WV	1 μ F		PB PRINTED CIRCUIT BOARD	
				1578A RECORDER INDICATOR	
RL	RELAY			1579 AFP INDICATOR	
201	G2E				
				D LED	
				401 SG 103D	
				402, 501 SR 103D	
				R RESISTOR	
				CARBON FILM	
PB	PRINTED CIRCUIT BOARD		401	1/4W	390 Ω
1577B					
D	DIODE				
301 ~ 305	Ge(GB)	1S1007(1N270)			
R	RESISTOR			ACCESSORIES	
	CARBON FILM			COAXIAL PLUG JPL 259	2
302	1/4W	82 Ω		DC POWER CORD # 240026	1
303, 304	1/4W	470 Ω		POWER PLUG QMS-6FK	(1)
301	1/4W	10K Ω		FUSE HOLDER SN-1102	(1)
				FUSE 30A 30A	(1)
VR	POTENTIOMETER			FUSE 30A	1
301	EVL VOAA	00B54 50K Ω B			
C	CAPACITOR				
	DIPPED MICA				
301, 302	50WV	180PF			
325	500WV	82PF			
327	500WV	100PF			
324	500WV	110PF(56PF \times 2)			
322	500WV	120PF			
326	500WV	130PF(68PF \times 2)			
323	500WV	150PF			
321	500WV	170PF(82PF \times 2)			
319	500WV	270PF			
318, 320	500WV	300PF			
316	500WV	390PF			
317	500WV	680PF(300PF \times 2)			
315	500WV	620PF			
313	500WV	680PF			
310, 312, 314	500WV	1200PF			
311	500WV	2000PF			
	CERAMIC DISC				
303 ~ 308	50WV	0.01 μ F			
	ELECTROLYTIC				
328, 329	16WV	1 μ F			
TC	TRIMMER CAPACITOR				
301	ECV-12W 10 \times 32	10PF			
T	TRANSFORMER				
301	CM COUPLER	# 220027			



NOTE
 1 ALL RESISTORS IN Ω , K OR M UNLESS OTHERWISE NOTED
 2 ALL CAPACITORS IN μF UNLESS OTHERWISE NOTED

FL-110
 CIRCUIT DIAGRAM

